PEARSON EDEXCEL IGCSE PHYSICS · 4PH1

PHYSICS



MARK SCHEME

SECTION 6: MAGNETISM AND ELECTROMAGNETISM (PACK 1)

SCORE	PERCENTAGE
/180	%

STEMUP

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Mark Scheme

Q1.

Question number	Answer	Notes	Marks
(a)	(turning handle makes) coil **turn / rotate**; coil **cuts** through; magnetic **field** (of the permanent magnets);	reject if suggested that coil rotation is due to motor effect ignore 'interacts with'	3
(b) (i)	speed = frequency × wavelength;	allow standard symbols and rearrangements allow v, c, s for speed allow λ for wavelength	1
(ii)	substitution; rearrangement; evaluation; e.g. $3.0 \times 10^8 = 93 (\times 10^6) \times$ wavelength wavelength = 3.0×10^8 / $93 (\times 10^6)$ (wavelength =) 3.2 (m)	ignore units until evaluation 1 mark may be awarded in the absence of any others for correctly converting MHz to Hz POT error scores 2 marks max. allow 3.2258...(m)	3
(c) (i)	any four from: MP1. loudspeaker (coil) has a current / magnetic field; MP2. interaction between magnetic fields; MP3. causes a force to be exerted on speaker (cone); MP4. a.c. changes direction; MP5. force on speaker (cone) changes direction; MP6. causes speaker (cone) to vibrate;	 allow 'interferes' for interacts	4
(ii)	any one from: increase strength of magnet; use a larger current; use more turns of wire on loudspeaker coil;	ignore references to adding iron core ignore 'increase size of magnet' allow larger voltage (across coil) allow 'more coils of wire'	1
		Total for Question = 12 marks	

Q2.

Question number	Answer	Notes	Marks
(a)	any FOUR from: MP1. idea of magnetic field around coil (when current flows); MP2. idea of interaction between fields of magnet and coil; MP3. idea of force on coil from magnet; MP4. idea of alternating force on cone; MP5. cone vibrates; MP6. idea that cone forces air to vibrate; MP7. longitudinal wave formed;	ignore references to induction allow 'tube' for 'cone' allow idea of series of compressions and rarefactions	4
(b) (i)	substitution; evaluation; correct answer = 0.11 (W) e.g. power = current × voltage = 0.15 × 0.75 power = 0.1125 W	-1 for POT error	2
(ii)	suitable linear scale chosen (>50% of grid used); axes labelled with quantities and units; all plotting correct to nearest half square;	ignore orientation	3
(iii)	attempt at fitting first two points and fitting rest of points separately; single curve with a peak within one large square of third point;	ecf candidate's plotting max 1 mark for straight line consistent with candidate's plotting	2
(c)	any FOUR from: MP1. for diagram 4, cell voltage no longer shared; MP2. means current through each loudspeaker is doubled; MP3. so current from supply is four times higher; MP4. correct use of 'R = V/I'; MP5. (so) total resistance is a quarter of that from the series case;	accept voltages in parallel are the same accept voltage is shared in diagram 3 accept idea of current from each branch adds to give total current in cell accept higher order answers in terms of series and parallel equations accept calculation of both circuit's total resistance	4
			(Total for Question = 15 marks)

Q3.

Question number	Answer	Notes	Marks
(a)	2.8 (mA);	allow -2.8 (mA)	1
(b) (i)	same value as (a) but opposite polarity e.g. -2.8 (mA);	allow ecf from (a)	1
(ii)	reading larger than value given in (a);	ignore polarity	1
(c)	any one from: MP1. longer needle; MP2. more turns in coil; MP3. stronger magnet; MP4. weaker return spring;	allow idea of moving scale further up the needle ignore bigger coil, more coils ignore bigger magnet	1
(d) (i)	A (accuracy); B is incorrect because no repeats are being taken C is incorrect because no repeats are being taken D is incorrect because the scale of the ammeter is the same		1
(ii)	idea of subtracting/adding the difference/error from the measurement;	allow subtract/add a quoted value of current even if value is incorrect	1
		Total for Question = 6 marks	

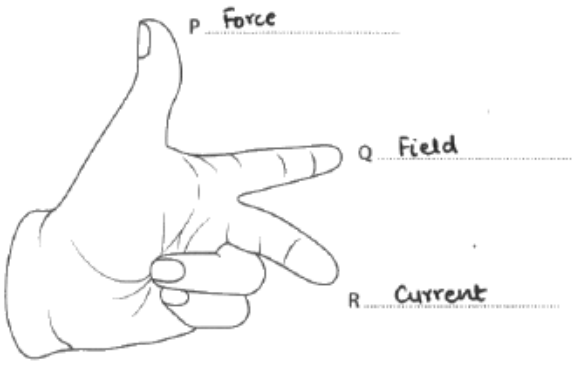
Q4.

Question number	Answer	Notes	Marks
(a)	method to show shape; e.g. use compass(es) use of iron filings/powder use of plotting compass **to show direction**; a further method detail; e.g. mark card/move compass/multiple compasses idea of another line or lines added sprinkle (iron filings) tap card (to distribute iron filings)	all marks may be awarded from a labelled diagram	3
(b) (i)	any four from: MP1. idea that core **gains** a magnetic field; MP2. idea of a changing magnetic field; MP3. idea that field lines cut by wire; MP4. voltage induced (across coil); MP5. (causing a) current in the wire;	allow higher level ideas in terms of flux and flux linkage	4
(ii)	any one from: MP1. idea that dynamo-wheel friction makes bicycle harder to pedal; MP2. idea that lights would vary in brightness; MP3. lights will be off when bicycle is stationary;	allow current / brightness of lamps depends on how fast bicycle is moving	1

Q5.

Question number	Answer	Notes	Marks
(a)	calculation of energy transferred by battery; efficiency formula stated; correct substitution; evaluation; e.g. energy supplied = VIt = 12 × 0.25 × 12 = 36 (J) efficiency = <u>useful energy output</u> total energy output efficiency = 25 / 36 (×100%) efficiency = 69 (%)	36 (J) seen seen or implied anywhere in working allow ecf from battery energy if clear 25/36 (×100) seen allow 70, 69.4...(%)	4
(b) (i)	current / coil has a magnetic field; interaction between fields; resulting in a force; forces on opposite sides of the coil are in opposite directions;	 ignore references to attraction / repulsion	4 1
(ii)	C - YZ; A is incorrect because WX moves downwards B is incorrect because part of XY moves downwards D is incorrect because part of ZW moves downwards		

Q6.

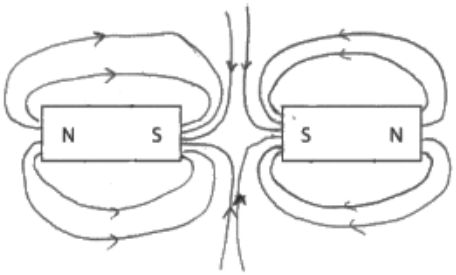
Question number	Answer	Notes	Marks
(a)	thumb: (magnetic) force; index finger: (magnetic) field; middle finger: current; e.g.  	CONDONE "motion" ALLOW correct symbols eg I for current	3
(b)	3 field lines with arrow from North to South; field lines parallel and evenly spaced;	IGNORE any lines drawn outside of the space between the poles	2

Question number		Answer	Notes	Marks
(c)	(i)	a.c. current changes direction frequently/continuously/repeatedly/50 Hz; d.c. current is in one direction only;		2
	(ii)	(to / towards) right;	ALLOW in	1
	(iii)	battery supplies constant current; idea of no vibration;	ALLOW idea that battery provides a direct current	2

Q7.

Question number	Answer	Notes	Marks
(a)	one mark for each correct row;;; Energy store in magnet B / Increases / Decreases / Stays the same gravitational / ✗ / ✓ / ✗ magnetic / ✓ / ✗ / ✗ kinetic / ✗ / ✗ / ✓		3
(b)	downward arrow labelled "weight"; arrow same length as upward force arrow;	ignore gravity allow gravitational force, gravitational pull ignore arrows associated with magnet A judge by eye	2
(c)	any five from: MP1. caliper (to measure distance); MP2. balance (to check mass is 10g); MP3. use of set square to ensure vertical distance; MP4. independent variable identified as the mass added; MP5. dependent variable identified as the distance; MP6. repeat readings and find mean (average); MP7. plot graph of results; MP8. (identify and) remove / ignore anomalies;	allow any marking point if clear from diagram allow ruler, measuring tape allow scales	5
(d)	any three from: MP1. idea of magnet C providing a downward force on magnet B; MP2. idea that total downward force on magnet B is greater (than before); MP3. (creating) resultant downward force on magnet B; MP4. idea that (upward) force of magnet A on magnet B increases (when B moves down the shaft); MP5. (because) idea that decreased distance gives stronger magnetic field (between A and B);	ignore any references to magnets having different strengths allow "B is repelled by C" / eq allow idea that total downward force greater than upward force allow A repels B more strongly	3 Exp
			Total for question 4 = 13 marks

Q8.

Question number	Answer	Notes	Marks
(a)	MP1. method to show shape; e.g. use compass(es) use of iron filings / powder MP2. use of plotting compass **to show direction**; MP3. a further method detail; e.g. move compass / multiple compasses in different positions idea of another line or lines added sprinkle iron filings (on to card) tap card (to distribute iron filings)	all marks may be given from diagram allow if compass seen in diagram pointing in a suitable direction allow equivalent materials to card e.g. paper, plastic etc.	3
(b)	correctly drawn field line patterns for both bar magnets; correctly drawn field line pattern for region between the magnets; at least three field line directions given from north to south;  	 should show no lines linking south poles not every line needs to have an arrow reject mark if directions contradict 2 marks max. if any lines overlap condone lines touching	3

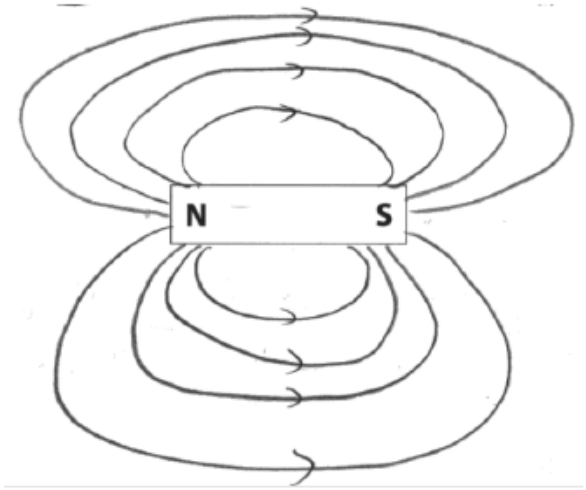
Q9.

Question number	Answer	Notes	Marks
	any five from: MP1. electrical/electric current is a.c.; MP2. loudspeaker coil has a current / magnetic field; MP3. interaction between magnetic fields; MP4. causes a force to be exerted on speaker (cone); MP5. a.c. changes direction; MP6. magnetic field of coil changes direction; MP7. force on speaker (cone) changes direction; MP8. causes speaker (cone) to vibrate; MP9. making longitudinal wave;	 allow 'interferes' for interacts ignore references to attraction / repulsion allow vibrates the air	5

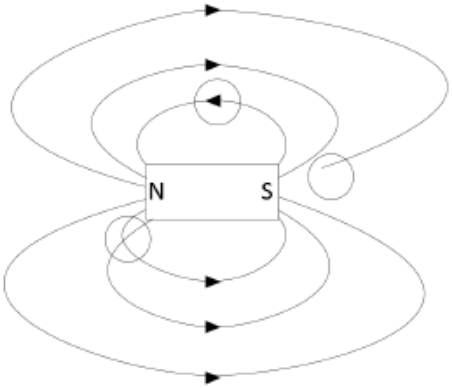
Q10.

Question number		Answer	Notes	Marks
(a)		idea that like poles repel;		1
(b)		it is made of plastic / idea that plastic is non-magnetic;		1
(c)		correct shape e.g. lines deviating away from both magnets; correct direction e.g. any arrows must face towards poles;	reject if any field lines touch or cross except at pole	2
(d)	(i)	reading will increase; (because) magnetic field / (repulsive) force will be stronger;	 allow statement to the effect that magnet B will be pushed down more (by magnet A)	2
	(ii)	reading will decrease; (because) magnets will now attract;	allow reading will become negative / zero ; allow statement to the effect that magnet B will be pulled upwards	2

Q11.

Question number	Answer	Notes	Marks
(a)	at least four lines leaving/entering poles; at least one loop 'above' and one loop 'below'; arrowheads on at least four lines which are self-consistent;  	accept part loops ignore field lines that cross	3
(b)	idea of wire cutting field lines; idea of an **induced** voltage;	allow higher order ideas involving flux linkage	2
		(Total for Question = 5 marks)	

Q12.

Question number	Answer	Notes	Marks
(a)	(plotting) compass(es);	allow **suspended** magnet, magnetometer allow higher level responses e.g. Hall probe, search coil	1
(b)	one mark for each correct indication;;;  	2 marks max. if more than three indications given	3
(c)	any two from: difficult to magnetise; difficult to demagnetise; idea that it retains its magnetism;	 allow idea of taking a long time to magnetise allow idea of taking a long time to demagnetise	2
		Total for Question = 6 marks	

Q13.

Question number	Answer	Notes	Marks
(a)	B; A is incorrect because the top two field lines are in the wrong direction C is incorrect because all the field lines are in the wrong direction D is incorrect because the second field line from the top is in the wrong direction		1
(b) (i)	B; A is incorrect because there is a magnetic force on each of the magnets C is incorrect because the two nearest poles are opposite not alike D is incorrect because the forces on the magnets pass through their centres of gravity		1
(ii)	C; A is incorrect because the field lines are not straight nor parallel to each other B is incorrect because the field lines are not straight nor parallel to each other D is incorrect because the field lines are not parallel to each other		1
(c)	steel / nickel / cobalt / neodymium;	condone iron	1
(d)	EITHER: (plotting) compass used; multiple compasses or repeated use of single compass; joining up of dots/idea of compasses forming continuous line; OR iron filings used; sprinkled / eq; card tapped (to reveal pattern);	all marks can be awarded from a diagram ignore 'poured' or other heavy-handed method	3

Q14.

Question number	Answer	Notes	Marks
(a)	arrows drawn on sides WX and YZ one up, one down; arrow on WX down, arrow on YZ up;		2
(b)	any four from: MP1. magnetic field around the wire; MP2. interaction between this field and the field from the magnet; MP3. (produces) a force on wire / coil; MP4. forces on opposite sides of the coil are in opposite directions; MP5. coil starts to rotate;	 allow magnetic field overlap also scores MP3 allow coil rotates / turns / spins	4
(c)	force (on wire/coil) increases; (therefore) rotation speed is greater;	allow stronger magnetic field around wire/coil allow coil spins faster	2
		Total for question = 8 marks	

Q15.

Question number	Answer	Notes	Marks
	north; steel; hard; north; soft;	this order only	5

Q16.

Question number	Answer	Notes	Marks
(a)	north pole labelled on magnet Y; lines drawn straight and vertical between magnets; lines are equally spaced with arrows pointing upwards;	ignore curved lines at the edges of the magnets	3
(b) (i)	any two from: MP1. iron is (a) magnetic (material); MP2. iron ball becomes a magnet / becomes magnetised (N pole at top); MP3. iron ball is attracted to the magnet;		2
(ii)	downward arrow drawn shorter than magnetic force arrow;	ignore starting point of arrow, judge length and direction only	1
(iii)	weight = mass × gravitational field strength;	allow standard symbols and rearrangements e.g. m = W / *g*	1
(iv)	calculation of weight; dimensionally correct substitution into weight formula; rearrangement; evaluation; e.g. weight = (165 – 124 =) 41 (mN) 0.041 = mass × 10 (mass =) 0.041 / 10 (mass =) 0.0041 (kg)	ECF if incorrect weight or 165, 124, 289 used as the weight allow g=9.8, 9.81 -1 for POT error provided 10 (N/kg) is used somewhere 0.0165, 0.0124, 4.1 gets 3 marks max 16.5, 12.4 gets 2 marks max	4
(v)	any two from: MP1. weight (of the iron ball) stays the same; MP2. magnetic force increases; MP3. magnetic field strength increases;	allow greater attraction from magnet	2

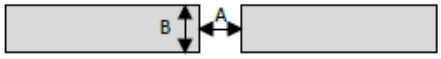
Q17.

Question number	Answer	Notes	Marks
(a)	magnet moves through / near coil of wire; field lines of magnet are cut by coil; idea that voltage is induced across the coil;	allow idea that magnet enters / leaves coil ignore references to the coil having its own field ignore references to current	3
(b)	any two from: MP1. shaking torch harder / faster; MP2. increasing the number of turns on the coil; MP3. using a less resistive metal for the coil of wire;	allow moving coil/magnet faster ignore "larger coil"	2
		Total for Question = 5 marks	

Q18.

Question number	Answer	Notes	Marks
	any five from: MP1. current in coil produces magnetic field; MP2. direction of this magnetic field is (continuously) changing; MP3. field of coil interacts with field of magnet; MP4. producing a force on coil/wire; MP5. direction of the force changes; MP6. cone/coil/wire vibrates; MP7. air particles (next to the cone) are made to vibrate;	allow coil is magnetised / becomes an electromagnet allow cone moves in and out / backwards and forwards	5
		Total for Question = 5 marks	

Q19.

Question number	Answer	Notes	Marks
(a)	two magnets with opposite poles facing; poles brought close to each other;  	accept annotated diagram for either mark accept from diagram if magnets drawn closer together than the thickness of their poles i.e. A < B (on diagram)	2
(b) (i)	any three from: MP1. ammeter displays a current/reading (in one direction); MP2. (because) a voltage is induced; MP3. induced voltage gives a current; MP4. ammeter reading goes negative / shows current in opposite direction; MP5. (because) wire changes direction;	 allow 'an alternating current / a.c. is produced'	3
(ii)	any four from: MP1. ammeter reading / current is greater (than before); MP2. because wire moving quicker; MP3. more field lines cut (per second); MP4. gives a larger induced voltage; MP5. frequency of alternating current increases;	 allow idea that direction of current changes more frequently	4
		Total for Question = 9 marks	

Q20.

Question number	Answer	Mark
(a)	An arrow on the line CD pointing upwards	1

Question number	Answer	Mark
(b)	Any one from the following: • reverse polarity of magnetic field/equivalent • reverse direction of current/equivalent	1

Question number	Answer	Mark
(c)	Any two from the following: • decrease current/(battery) voltage/equivalent (1) • decrease strength of magnet/equivalent (1) • increase friction (in bearings) (1)	2

Q21.

Question number	Answer	Notes	Marks
(a)	use of voltage = current × resistance; calculation of voltage across 240 ohm resistor (2.88 V); idea that voltages of two resistors in series adds up to supply voltage; evaluation of voltage across R; e.g. $V = I \times R$ $V_{240} = (0.012 \times 240 =) 2.88$ (V) $V_R + V_{240} = 9.2$ (V_R =) 6.3 (V)	allow rearrangements and standard symbols calculate total resistance of circuit (767 Ω) evaluation of resistance of R (527 Ω) evaluation of voltage across R (using V = IR) allow 2.9 (V) allow 9.2 – 2.88 or V + 2.88 = 9.2 allow 6.32 (V) if mA not converted to A and 2880 seen then award 2 marks max.	4

(b)	(i)	any three from: MP1. coil produces a magnetic field; MP2. (which) interacts with the magnetic field of the (permanent) magnet; MP3. producing a force acting on the coil; MP4. opposite forces on either side of coil; MP5. coil rotates / turns;	 allow coil becomes an electromagnet allow one side is pushed up and the other is pushed down allow coil spins, pointer moves (to the left)	3
	(ii)	vertical arrow UP (on wire CD);		1
	(iii)	any three from: MP1. more turns on the coil; MP2. stronger (permanent) magnet; MP3. add an iron core; MP4. producing a larger force (for the same current); MP5. use of a longer pointer; MP6. use of a weaker return spring; MP7. producing a greater movement at the end of the pointer (for the same current);	 allow "more coils" allow method to increase field strength e.g. moving magnets closer together allow producing the same force for a smaller current allow same movement for a smaller current	3

Q22.

Question number	Answer	Notes	Marks
(a) (i)	any THREE from: trolley changes direction; induction depends on direction of relative motion; idea that voltage has changed directon (as sign of voltmeter reading depends on direction of voltage); idea that at ends of motion, voltage is zero;	condone current for voltage ignore idea induction depending on speed	3
(ii)	speed may change/ magnetic field may not be uniform;	accept idea that magnetic field may change allow idea of entering or leaving field	1
(b) (i)	substitution; re-arrangement; evaluation; correct answer: 1.8×10^{-4} (A) e.g. charge = current × time 1.4×10^{-4} = current × 0.78 current = $(1.4 \times 10^{-4}) \div 0.78 = 1.79 \times 10^{-4}$ (A)	substitution and rearrangement in either order -1 POT error	3
(ii)	substitution; re-arrangement; evaluation; correct answer: 1.6×10^{-2} (V) e.g. energy = charge × voltage $2.3 \times 10^{-6} = 1.4 \times 10^{-4} \times$ voltage voltage = $(2.3 \times 10^{-6}) \div (1.4 \times 10^{-4}) = 1.64 \times 10^{-2}$ (V)	allow use of standard symbols e.g. $E = Q \times V$ allow v,V for voltage reject C,c for charge substitution and rearrangement in either order -1 POT error	3
		(Total for Question = 10 marks)	